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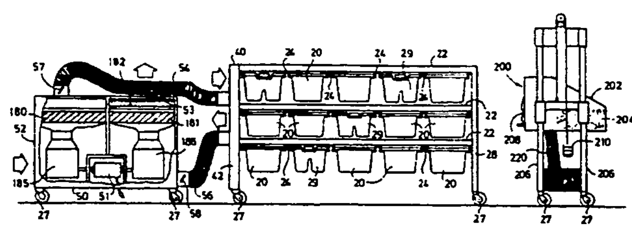
(54) **Animal caging system.**

(57) An improved animal caging system of the type having a plurality of ventilated cages suspended on flanges from a plurality of shelves is provided. The ventilation duct system is entirely enclosed and forms an integral part of the caging system rack. Means mounted in the air ducts for controlling airflow to and from cages, and an arrangement for a tight fit between the cages and the ducts minimize the possibility of cross-infection between occupants of different cages, and between people and cage-occupants. Airtight cages may be employed with valves actuated upon insertion of the cage into the rack, whereby sealed cages may be transported in safety. A negatively pressurized isolation box, adapted to interface with the cage rack, permits manipulation and servicing of cages and occupants, resulting in a contagion-safe total system.



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Housing a large number of animals poses problems in s plying animals with basic needs such as air and food, as well a: the aforesaid problem of infection. In some prior art systems, b ks of animal units have been individually fitted with pipe c ınections to supply and exhaust air, and sometimes to flush refuse from the animal housing unit. When a large number of animal units are mounted in a relatively small space, this maze of individual connections can be a nightmare for the person servicing the animals. This problem is only partially solved in systems that employ press-fit tube connections. On insertion of an animal unit in a system employing press-fit connections, the installer must visually line up the receptacle in the animal unit with the pipe in the rear of the mounting rack before the cage can be put in its final position. Inexact lineup of cages wastes supply air, may introduce pathogens, and may release contagion-bearing exhaust air. The complexity and inconvenience of individually piped systems clearly generates a substantial expense upon purchase and with continuing use, to laboratories that employ them.

In less demanding applications where some cross-ventilation can be tolerated, former animal housing systems have often employed laminar flow ventilation. In laminar flow ventilation systems, air is supplied via a plenum over an entire bank of animal units. Theoretically, in such a system all the portions of cage ventilation air move parallel to all the other portions,

nstallation and removal are likely to be inconvenient, requiring onnection or disconnection of some sort of coupling. Conversely, system which features convenience of installation and removal ill generally do so at the expense of dependable, airtight ouplings. The present invention seeks to resolve this dichotomy in a system applicable to a range of applications.

The present invention provides a system whereby the cross-ventilation advantages of an individually-piped system are obtained, as well as the installation and removal convenience of a one-sided laminar flow system. The animal cages are individually removable, yet tapered flanges and gasketing allow the cages to be fitted tightly against the supply and exhaust ducts in a way as effective at reducing cross-ventilation as the individual piping method. Baffles may be mounted in the air ducts to minimize eddy and surface currents, and also help to minimize any cross-ventilation. For the most demanding applications, an airtight valve arrangement provides safe and secure connection. The support rack for the unit is hollow and also serves the function of duct work for supply of air to the individual cages and exhaust therefrom. The system is thus compact and convenient, solving both cross-ventilation and installation-removal problems in one.

Finally, the system is widely applicable due to inexpensive yet sturdy and dependable construction. In simple embodiment, it is useful in pet stores and non-demanding laboratory work. In a

Summary of the Invention

It is the object of this invention to provide a high ensity animal housing system that is as convenient to service as ı laminar flow ventilated system, and as effective at reducing cross-ventilation as an individually piped system.

It is also an object of this invention to minimize the space required for duct work and to more effectively utilize available space for cages and for service of cages in a multi-unit cage system.

It is also an object of this invention to protect occupants of a multi-unit cage system from air that has had contact with occupants of other units, and from the dander, refuse and airborne contagion of such other occupants.

It is another object of this invention to ensure that the occupants of a multi-unit cage system and the human occupants of the area wherein such system is located to not suffer from diseases or allergic reactions caused by cross-ventilation between their air and that of their respective counterparts.

It is still another object of this invention to provide as airtight a fit as convenience in a range of uses will allow between the cages in a multi-unit caging system and the ducts supplying and exhausting air to and from said cages, while precluding the necessity of careful alignment of cages with the ducts.

:t of the cages, in an embodiment with cages having open tops. A ɔre airtight connection may be achieved in another embodiment by ;e of cage lids. Sealing rings of rubber or other flexible ıterial are fitted in depressions along the surfaces of the lids ɜtween the cage lids and flanges on the upper edge of the cage bodies and between air openings in the lids and the ducted shelves. The lids may also comprise valves mounted in air openings the valves having spring-loaded pistons. When a cage is inserted, the valves are forced open to supply and exhaust air. Upon removal of a cage, the valves close by release of the pistons to prevent the escape or access of contagion.

In alternative embodiments, one hollow end face comprising two supply and two exhaust ducts, or two hollow end faces, one a supply duct and one an exhaust duct, are provided. The shelves are divided into shelf ducts open to the appropriate supply and exhaust ducts at the ends thereof.

A tight fit between the cages and the hollow shelves is accomplished by the aforesaid system also comprising: flat shelf flanges mounted under each hollow self; and, cage flanges along the top edge of said cages, upon which said cages are slideably insertable and removable along said shelf flanges, each said cage flange having a thicker flat center area, and two sloping areas to either thinner end of said cage flange, said thicker flat center area being of the same thickness as the space between said shelf flange and said hollow shelf. A like result is obtained in a system wherein said shelf flanges mounted under each said

Brief Description of the Drawings

For the purpose of illustrating the invention, there are shown in the drawings forms which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Fig. 1 is a plan view of the complete system, the ventilation apparatus shown cutaway;

Fig. 2 is a perspective view illustrating installation and removal of a typical animal unit in a system having open-top cages;

Fig. 3 is a perspective breakout view showing ducting and baffle arrangements within the system framework;

Fig. 4 is a plan view of a cross-section of a self and duct;

Fig. 5 is a perspective view of a system rack for a single depth embodiment;

Fig. 6 is a perspective view of a shelf flange for use with a flat cage flange;

Fig. 7 is a perspective view of a cage flange for use with a flat shelf flange;

Fig. 8 is a perspective breakout view of an alternative duct and shelf duct arrangement;

Detailed Description of the Drawings

Fig. 1 illustrates the multi-unit animal caging system of this invention. As also shown in Fig. 2, in a multi-unit system of this kind, animal cages 20 are suspended on a rack structure 40 from hollow shelves 22, for example by means of shelf flanges 24. The animal cages 20 are equipped with cage flanges 26 which rest on shelf flanges 24 such that the cages 20 can be slideably inserted and withdrawn. The system holds cages 20 on both a front side 28 shown in Fig. 1, and a rear side, not shown.

An air input source 52 draws air into the system. The air supply can be conveniently provided by the external system 50 of Fig. 1, ducted into the rack via flexible hoses 54, 56, or the supply can be built into the rack structure 40, for example, in a hollow bottom. To minimize vibration, the external system 50 is preferred. The ventilation apparatus 50 supplies air to the cages, and expels air from the system through an exhaust opening 53. The system's air input and exhaust may be connected to any appropriate source and to any appropriate discharge, for example, to a permanently-installed room ventilation plant.

The scheme of the invention is to provide complete duct work as integral parts of the structure supporting the cages. With reference to Fig. 1, air entering at input 52 is filtered and ducted into the rack structure 40 via hose 54. End face 42 is

Hollow shelves 11 are shown in Fig. 3 equipped with affles 70 at each cage position. The baffles 70 direct airflow nto and out of the cages 20, and minimize eddy currents in the enter shelf duct 62 and side shelf ducts 64. The baffles 70 perate to minimize movement of contagion in a direction opposite irflow. The effectiveness of the baffles is increased by their curvature, and by use of larger baffles in the direction of input airflow, and smaller baffles in the direction of exhaust airflow, in keeping with aerodynamic principles.

A duplex type cage 21 is shown in Fig. 2, in position for insertion under shelf 22. Water bottles may be mounted in supporting mesh as shown, or water may be supplied in other ways as known in the art. Cage 21 is supported below shelf 22 by cage flanges 26 resting on shelf flanges 24. When fully inserted, cage 21 is stopped by protruding ridge 23, under shelf 22.

Figs. 6 and 7 illustrate means for achieving a tight fit between cages 20 and hollow shelves 22 to minimize cross-ventilation. In Fig. 6, shelf flange 24 comprises a flat area 72 at the extreme of travel of cages 20, a sloping area 73 varying the thickness of said shelf flange from thicker at flat area 72 to thinner at the end of sloping area 73, and a lower flat area 74. The corresponding cage flange 26 has a width varying from thin at the ends of cage flange 26, sloping along inclined areas 77 to a central flat area 76, said central flat area occurring at a point where the width of the cage flange 26 is substantially

:omprises one wide air supply duct 82 and two air exhaust ducts 1 and 83. Each shelf 22 of the rack structure comprises cor- esponding shelf ducts for supply 92 and exhaust 91 and 93. upply and exhaust ducts 81, 82, 83 communicate with supply and xhaust shelf ducts 91, 92, 93 through openings or passageways 101, 102, 103 respectively. Means are provided for connecting ducts 81, 82 and 83 to an external ventilation system, and are shown in Fig. 1, in the preferred embodiment. It will be appreciated that full width ducts as in Fig. 3, or two duct systems (for a one cage deep system) are also possible.

To summarize the foregoing, integral ducting for a unit having two hollow rack end faces or a single hollow rack end face, as well as appropriate corresponding shelf ducts may be provided as needed for systems of one-deep cages or two-deep cages.

Fig. 4 illustrates the particulars of interconnection between hollow end face 42 and shelf 22. On the end of shelf 22 where the same are attached, a gasket 111 of rubber or similar material is compressed by bolts 114 and flange members 116, one of which flange members comprises a cage-supporting shelf flange 118. Shelf flange 24, of the standard variety, is affixed to shelf 22 via machine screw 120 and fastener 121. A sheet metal screw could also be used. With reference to Fig. 2, a screw should be provided through shelf flange 24 at the foldover between sheets 65, 63, that is, at junction 66. By this means,

shelf ducts 91, 92 to the cage, via said valves. Inasmuch as valves 160 are held normally closed when the cage is not installed, the cages are sealed airtight. The openings in the shelf ducts are of a size slightly smaller than the bore in the valves. It will be appreciated that only a limited supply of air remains in the cage when removed from the rack.

Alternative air controlling means are also disclosed, for use in less demanding applications. Where cross-ventilation is tolerable, open top (i.e., lidless) cages are employed as in Fig. 2. Air controlling means comprising baffles 170 are mounted in the openings 140 in shelves 22, to direct airflow into and out of cages 20. In such a system, control of differential air pressure is important because the system leaks to some degree. With reference to Fig. 1, dampers 57, 58 are included to balance the supply and exhaust pressures. To provide maximum occupant protection, the supply pressure is adjusted to exceed the exhaust vacuum, allowing leaking supply and cage air into the room. To provide maximum protection to persons servicing the system, the exhaust vacuum is adjusted to exceed supply pressure, allowing some room air to leak into the cages.

A system of intermediate effectiveness comprises cage lids but no valves. Rather, a seal ring 162 surrounds the lid openings to seal lid 130 to shelf 22. Baffles 170 may be included, or a simple filter may be employed in place of baffles 170 to prevent dander and bedding material from being drawn into the

upwards to keep it normally closed, the spring pressing against cap 161 and piston 166. Cap 161 is perforated to allow air passing through the bore in piston 166 and thereafter along slots 163 along the lower periphery of the piston, to enter or leave the closed area within cage 20. A simple filter pad 167 is mounted in the exhaust valve to prevent larger particles from being drawn into the exhaust to foul the exhaust valve.

The lid and various valve parts can be made of plastic or metal. It is presently preferred that the lid be a hard clear plastic such as polycarbonate, the seat of a softer plastic or nylon, and the piston, spring and cap of stainless steel. In a system for rodents, occupants are inclined to gnaw on any part which protrudes, thereby requiring that unless a mesh 21 as in Fig. 2 is used, at least cap 161 must be made of metal. Moreover, unless some part is available for gnawing, a confined rodent's health will be adversely affected, the teeth growing continuously. A seal ring 132 is provided in an indentation in lid 130, as before, which completes an airtight seal when pressed against cage 20.

External filtration and air impelling means 50, as depicted in Fig. 1 are included in the presently preferred embodiment. The depicted fan motor 51 powers both supply and exhaust fans 185, 186. For the ultimate in safety, however, a separate motor should be provided in an airtight compartment for each, thereby avoiding contamination of the supply side should

In conjunction with the isolation chamber 200 of Fig. 12, the foregoing comprises a complete animal care system. Isolation chamber 200 comprises a transparent box 202 having sealed gloves 204 of rubber or plastic extending therein. A ventilation system comprising hose 200, fan 222, HEPA filter 224 and charcoal filter 226 maintains a negative pressure differential between box 202 and the room, and expels only cleaned air into the room.

The chamber 200 is adapted to interface directly with rack structure 40. An operator inserts his hands into gloves 204 and wheels chamber 200 up to the rack front 28. Box 202 is then raised or lowered along support bars 206 such that door 208 is placed against the shelf 22 just above the desired cage. Counterweight 210 eases raising and lowering of box 202. Box 202 is then lowered, tab 210 contacts shelf 22, and door 208 is opened as the box descends to align with the desired cage. The operator may then pull the cage into box 202. Preferably, the operator would again raise box 202 thereby closing door 208. However, the ventilation system can be operated at very high vacuum and door 208 left open. Once confined in box 202, the cage can be opened and the occupants serviced in safety.

Further variations on the inventive concept disclosed herein are possible and will now be apparent to those skilled in the art. Reference should be made to the appended Claims rather than the foregoing Specification as defining the true scope of this invention.

5. The animal housing system of claims 2 or 3, wherein said isolation box is moveable upon said mobile carriage, and said door comprises a contact tab adapted to engage said rack when said box is moved relative to said door.

6. A contagion-safe animal housing system of the type having hollow cages supported by a hollow rack structure, said system comprising:

(a) a source of clean air, and a discharge for exhaust air;

(b) a hollow rack structure both directing the clean air to animal cages supported thereby, and directing the exhaust air from said cages to said discharge.

(c) means for controlling airflow disposed between said rack structure and said cages.

7. The animal housing system of Claim 6, wherein the cages are supported by hollow shelves internally lengthwise divided into shelf ducts directing said clean air and said exhaust air to and from said cages, said shelf ducts being closed at one end thereof and open at an opposite end thereof to at least one hollow end face of said rack structure, said at least one hollow end face having integral ducts communicating with said source and said discharge and in which preferably said shelf ducts are each closed at the same one end thereof and open at the same opposite end thereof to a single hollow end face, said single hollow end face being internally lengthwise divided into at least one supply duct and at least one exhaust duct communicating with said source and said discharge.

said valves comprise valve seats disposed in said lids, said actuation means comprising spring-loaded pistons extending beyond said lids when said valves are closed, said pistons being axially bored through a portion thereof, and radially bored through the axial bore at a portion of said pistons which is moveably positioned to communicate with spaces within said cages when said cages are inserted into the rack structure, and moveably positioned to seal against said valve seat when said cages are withdrawn, said moveable positioning being actuated by contact between said pistons and said shelf ducts when the cages are inserted and withdrawn from the rack.

11. The animal housing system of Claim 10 further comprising seal rings disposed on said cage lids and extending therefrom, said seal rings adapted to seal the lids to the shelf ducts when the cages are inserted into said rack, and wherein said cages are preferably of double width, being joined in sealed pairs having a single lid, said lid having at least four means for controlling airflow mounted therein, means for controlling input airflow and means for controlling exhaust airflow being provided in staggered relationship for each cage.

12. The animal housing system of Claim 11, further comprising second seal rings disposed in grooves on said cage lids said second seal rings adapted to seal said lids to each of said cages.

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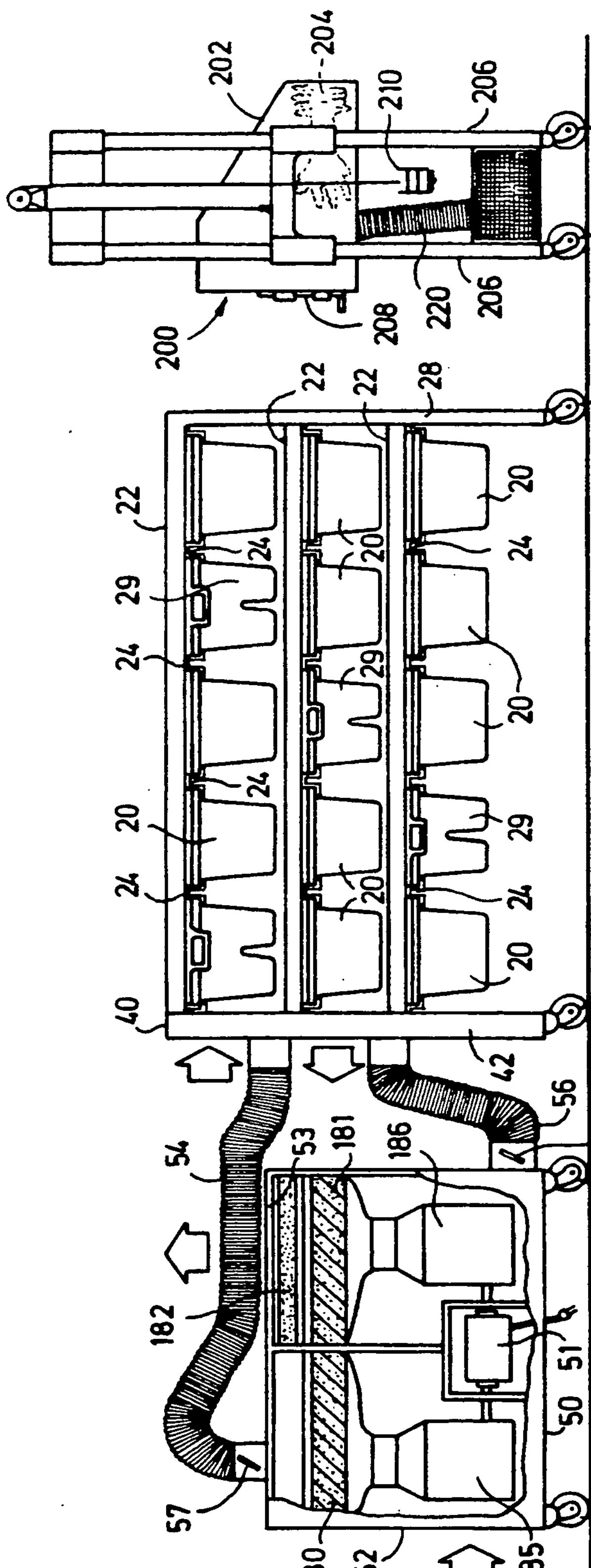

FIG.1

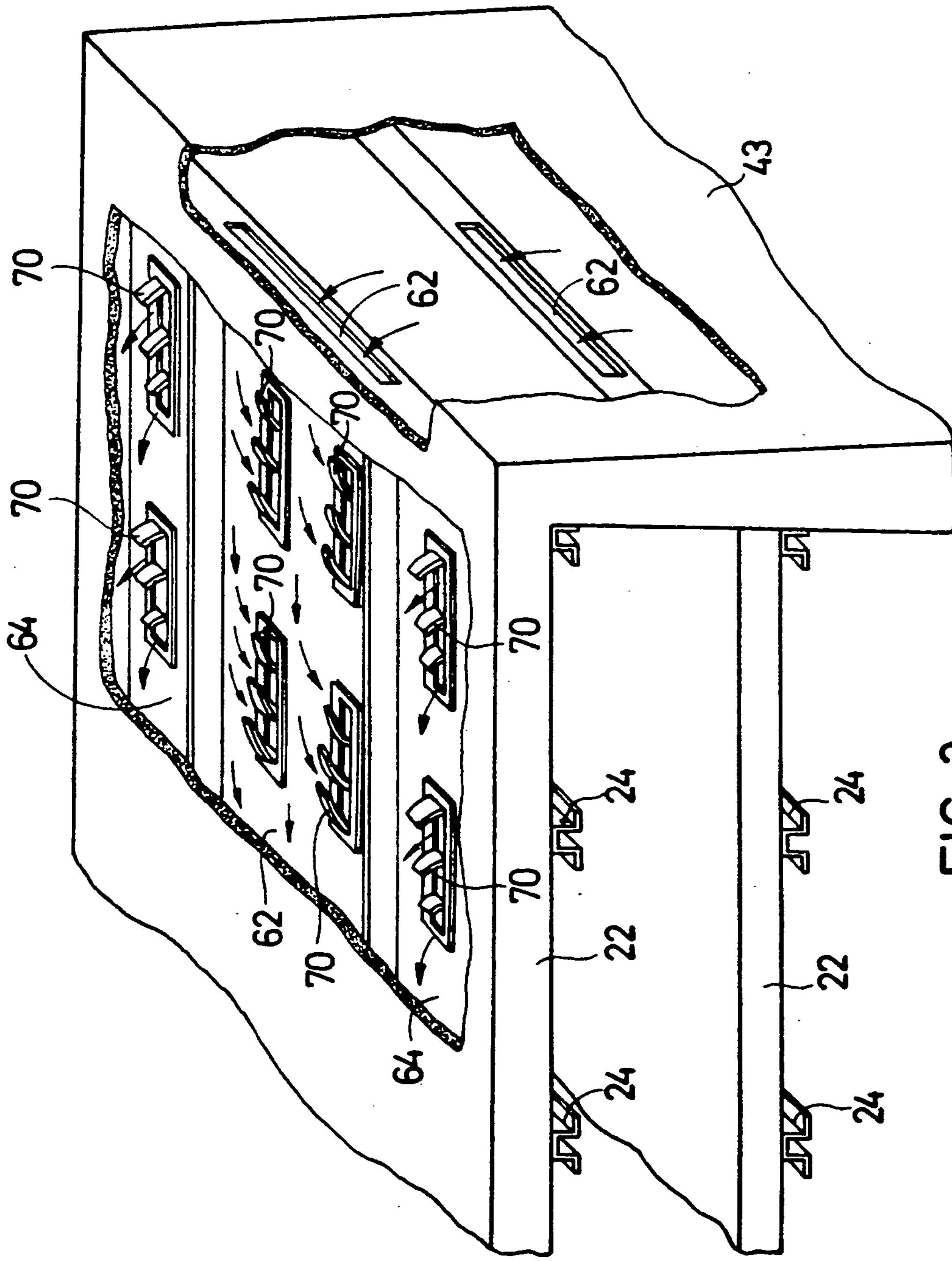

FIG. 3

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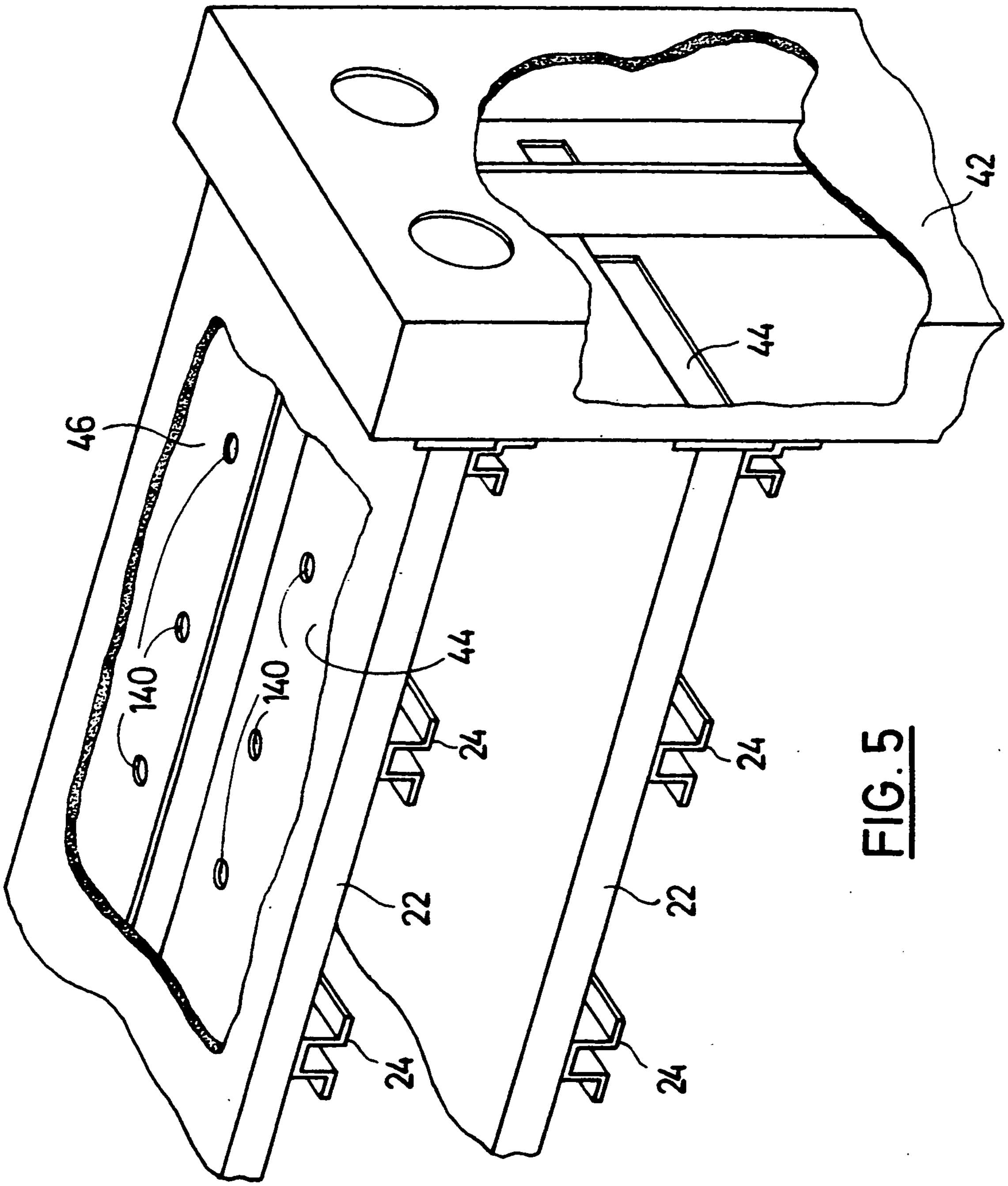

FIG. 5

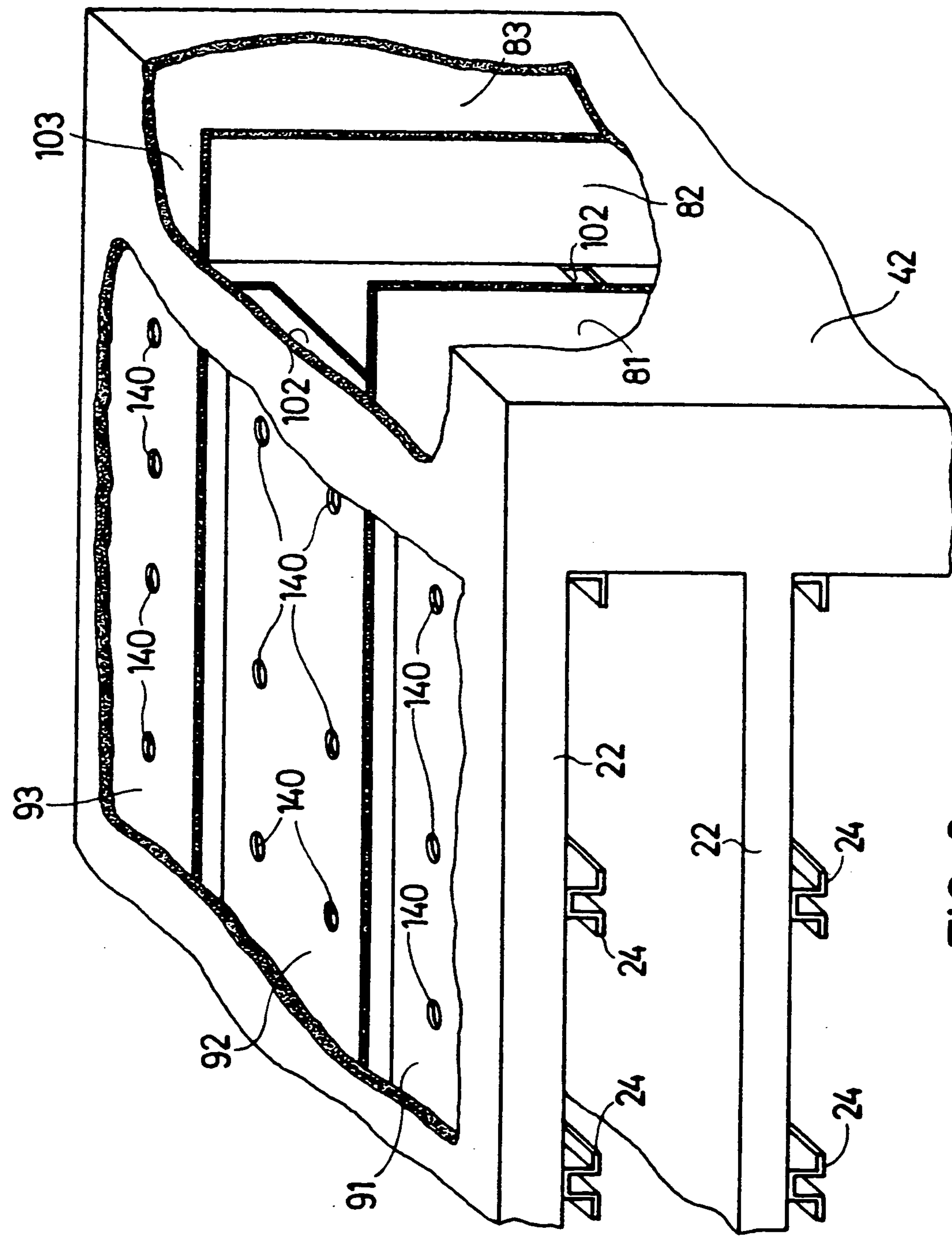
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FIG. 8

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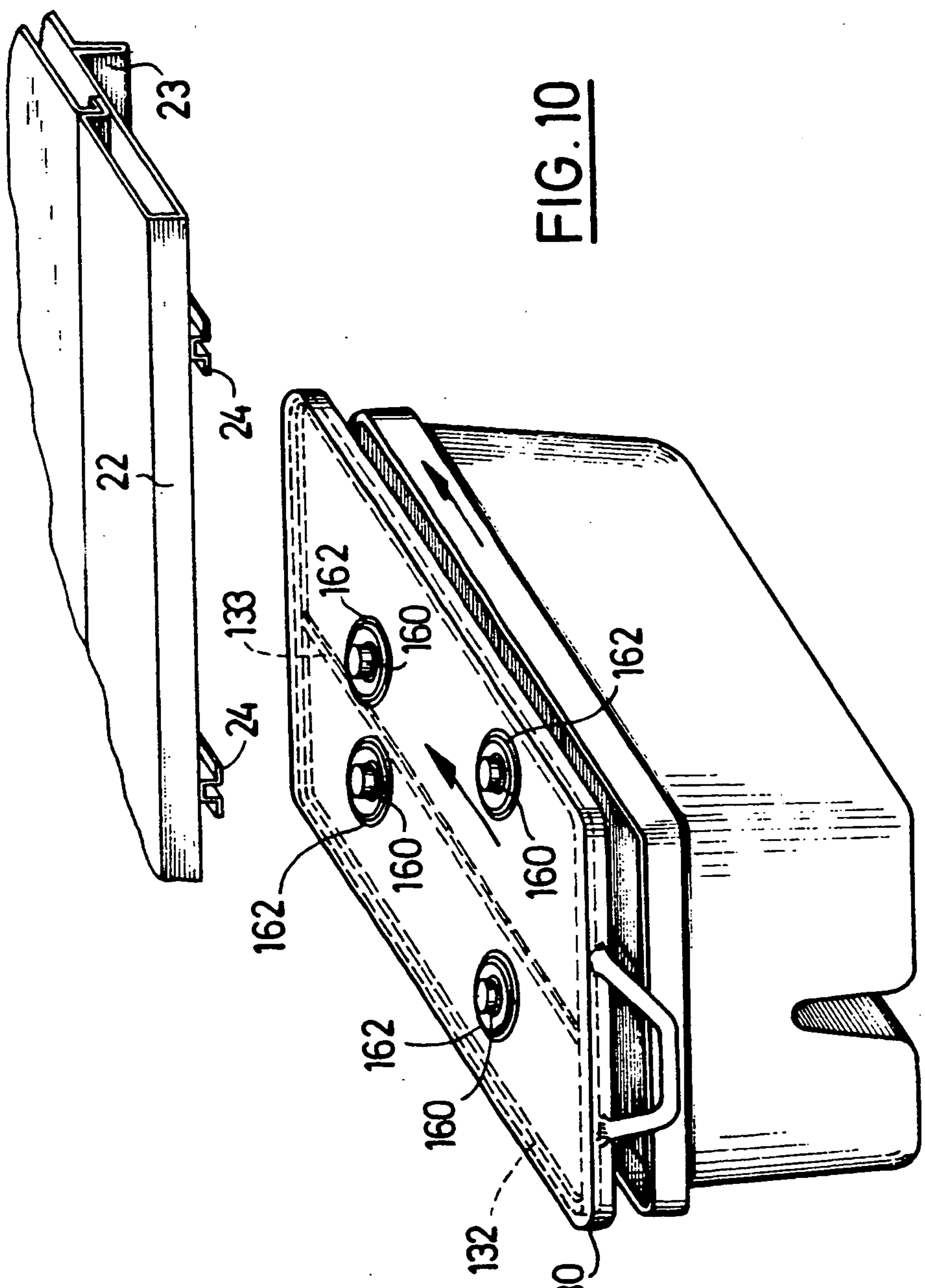

FIG.10

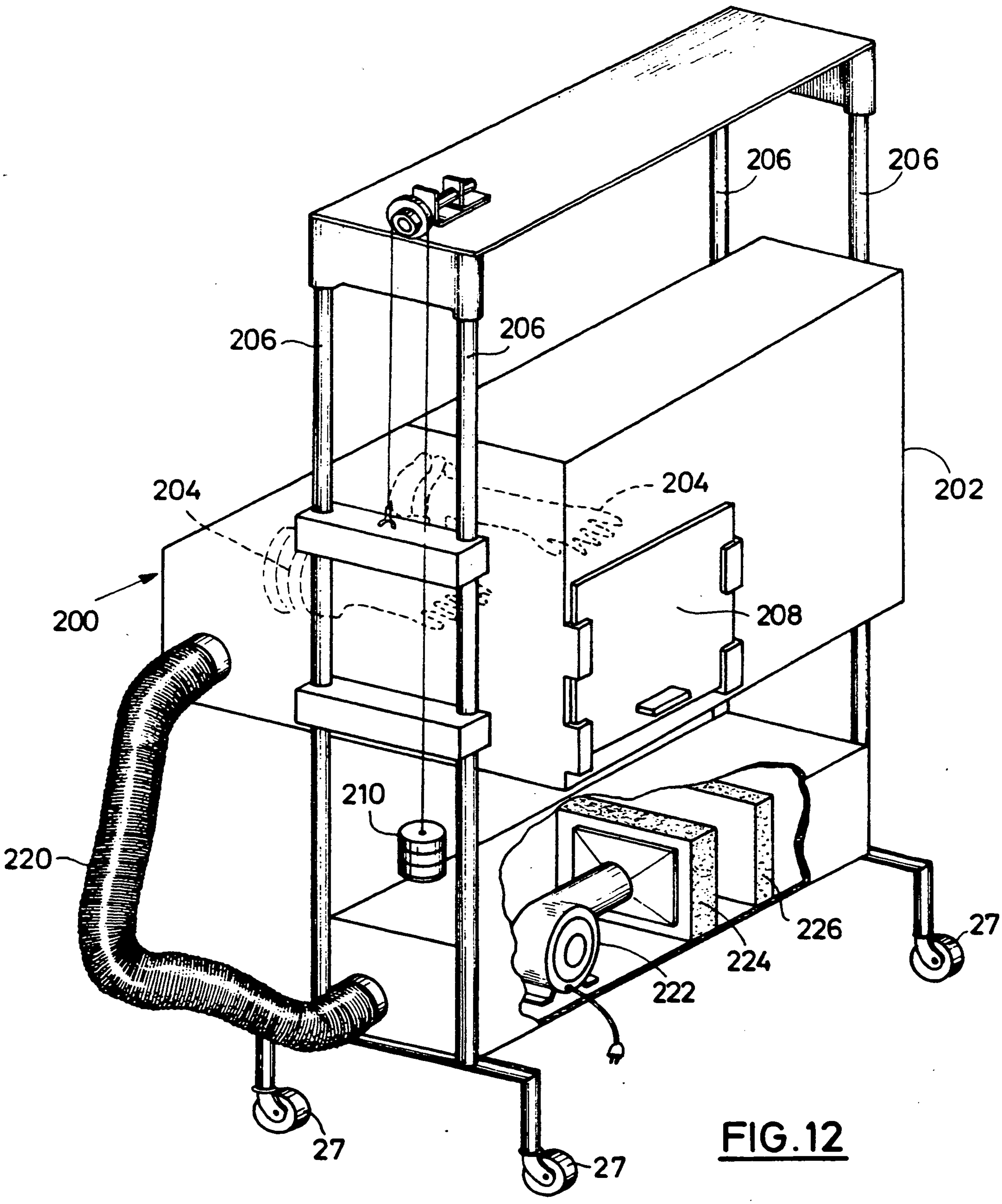

FIG.12